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Applicants: Teodor Aastrup et al.

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APPEAL BRIEF

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**Mail Stop: Appeal Brief
Commissioner for Patents
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Appeal Brief

Sir:

This is an Appeal Brief for the above-identified patent application that is being filed because it does not appear that the Examiner is considering the evidence that is of record herein and is more concerned with advancing a speculative theory to show the Examiner's technical knowledge in this particular field.

37C.F.R.§41.37(c)(1)(i). The real party at interest is Attana AB of Stockholm, Sweden.

37C.F.R.§41.37(c)(1)(ii). There are no related appeals or interferences known to applicants.

37C.F.R.§41.37(c)(1)(iii). The status of the claims are: (1) claims 1-5, 8-10 and 23-28 are rejected as unpatentable under 35 U.S.C. §103 over Thompson et al. (U.S. Patent Application 2003/0076743) in view of the Examiner's "scientific theory" and (2) claims 1-5, 8-10 and 23-28 are rejected as unpatentable under 35 U.S.C. §103 over Josse et al. (U.S. Patent Application 2003/0076743) in view of the Examiner's "scientific theory." It appears that dependent claims 6, 7 and 11-13 are allowable and pending, but it does not appear that claims 6, 7 and 11-13 have been withdrawn in any restriction.. Therefore, claims 1-13 and 23-28 are pending.

37C.F.R.§41.37(c)(1)(iv). The Listing of the Claims (claims 1-13 and 23-28) provided in Amendment E (filed 17 December 2008) are the current pending claims with Amendment E entered but not containing any claim amendments.

37C.F.R.§41.37(c)(1)(v). Summary of Claimed Subject Matter.

The claimed subject matter is based upon the surprising discovery that a thickness shear mode piezoelectric resonator can have improved sensitivity for mass measurements when the first electrode has a continuous surface area of less than 15 mm². The first sentence in the Description of the embodiments, specification page 6 lines 12-13, sums it up: "The present invention is based on the surprising finding that a smaller sensing electrode area leads to a largely increased sensitivity of a piezoelectric resonator." The claimed continuous surface area is less than any commercially available systems, and the art teaches and suggests that sensitivity can be improved with increased surface area, not decreased surface area.

More specifically, claim 1 provides limitations according to the following Table 1. Moreover, Table 1 summarizes which limitations are disclosed in the art and which limitations are novel. Novelty and patentability lies in limitation (b) for claim 1.

Table 1

Claim Limitation	Comment
Claim 1. A thickness shear mode piezoelectric resonator for use in a sensor arrangement for detecting or measuring an analyte in a medium by mass changes	Claim preamble ¹ . No limitation provided.
(a) a quartz crystal plate having a first crystal surface having an edge and a second crystal surface	Applicants consider that this limitation is provided in the two cited references.
(b) said first crystal surface comprises a first electrode having a continuous surface area of less than 15 mm ² and an electrode edge	The Examiner admits that neither cited reference discloses this limitation. More specifically, the prior art first crystal surfaces are larger in surface area. In addition, Thompson et al. suggest improving sensitivity by increasing edge dimensions, by drilling a hole in the first crystal surface, not by making it smaller. Further still, the Aastrup Declaration provides three contemporaneous references that sought to improve sensitivity by making the first crystal surface area larger, not smaller.
(c) said second crystal surface comprises a second electrode.	Applicants consider that this limitation is provided in the two cited references.

Dependent claims 2-5 depend from claim 1 and further limit the continuous surface area of the first electrode. Claims 2-5 are subject to the two current rejections.

Dependent claims 6 and 7 depend from claim 1 and provide an edge distance of the first electrode (claim 6) and rectangular shape of the first electrode (claim 7). Neither claim is subject to the two obviousness rejections, nor has either claim been withdrawn in a restriction.

Dependent claims 8-13 depend from claim 1 and further limit the configuration of the resonator of claim 1. Claims 8-10 are subject to both rejections. But claims 11-13 have not been rejected, have allowable subject matter and neither claim has been subject to a restriction.

Claims 23-28 are the method of using claims that use the resonator of claim 1 (claim 1 is incorporated into independent claim 23). More specifically, claims 23-28 are directed to a method of sensing or measuring using the resonator of claim 1. Dependent claims 24-28 depend from claim 23 and further limit the resonator in the same manner as claims 2-13.

37C.F.R.§41.37(c)(1)(vi). Grounds of Rejection to be Reviewed on Appeal.

A. Claims 1-5 and 8-10 and 25-28 were rejected as unpatentable under 35 U.S.C. §103 over Thompson et al. (U.S. Patent Application 2003/0076743) in view of the Examiner's "scientific theory."²

¹ A preamble is only limiting where "it recites essential structure or steps, or where it is necessary to give 'life, meaning and vitality' to the claims." *Intertool, Ltd. v. Texar Corp.*, 369 F.3d 1289, 1295 (Fed. Cir. 2004).

² For the purposes of this Brief, applicants are calling the "scientific theory" to be the "Examiner's speculation."

B. Claims 1-5 and 8-10 and 25-28 were rejected as unpatentable under 35 U.S.C. §103 over Josse et al. (U.S. Patent Application 2003/0076743) in view of the Examiner’s “scientific theory.”

Both rejections use the Examiner’s “scientific theory” (we shall call it the “*Examiner’s speculation*”) as a reference that is essential to support what is alleged to be a *prima facie* showing of obviousness. But what is the Examiner’s speculation? Unfortunately, the exact nature of the *Examiner’s speculation* has been an evolving concept and did not even make an appearance until the Fourth Office Action and was then embellished in the Fifth Office Action. The following description is made on an Office Action-by-Office Action basis in chronological order.

1. The First Office Action was dated 29 March 2007 and includes a rejection under 35 U.S.C. §103 over Josse et al. The *Examiner’s speculation* was not included in this Office Action. Instead, the Examiner admits that “Although Josse et al. does not disclose specific quantitative surface area, that is, specific dimensional/geometrical aspects of the electrodes . . . **Josse et al. does carefully teach and explain that ‘conductivity of the loading medium results in the expansion of the effective electrode surface area**, and that the electrode regions and their electrostatic capacitance is a result of the electrode size, shape and configuration, in other words, the electrode surface area.” (emphasis added) Therefore, the Examiner has now admitted that Josse et al. teaches away from the claimed invention by suggesting an “expansion” of the surface area, not a smaller surface area.

2. The Second Office Action was dated 21 September 2007 and includes a rejection under 35 U.S.C. §103 over Josse et al. The *Examiner’s speculation* was not included in this Office Action. The Examiner again makes the same quote (cited for the First Office Action) again admitting that Josse et al. suggests “expansion” of the surface area of the first electrode. However, now the Examiner has a response to arguments, and now mis-characterizes Josse et al. as teaching: “as shown by Josse et al., that these devices exist and would be motivated to employ the teachings (i.e. shapes of electrodes and sizes) and attempt, or obvious to try the disclosed electrode shapes of Josse et al. in devices wherein ‘mass changes’ are desired or measured or ascertained.” Therefore, in the Second Office Action the Examiner has not yet figured out the *Examiner’s speculation* but now provides an obvious to try approach, while ignoring the Examiner’s admission that Josse et al. teaches away from the claimed invention in the First Office Action.

3. The Third Office Action is two Advisory Actions, one dated 25 January 2008 and the second one (after a Supplemental Amendment B providing the Aastrup Declaration) dated 05 March 2008. The first Advisory Action does not say anything and does not provide the *Examiner’s speculation*. The second Advisory Action acknowledges the Aastrup Declaration but then inexplicably states: “The arguments presented in the Affidavit only support the Examiner’s position regarding the fact that altering the size of the electrode has a direct effect on its response

characteristic.” It appears that this is where the Examiner began ignoring the argument that the claimed invention makes the electrode smaller and that Josse et al (as was admitted by the Examiner) suggests making the electrode larger.

4. The Fourth Office Action was dated 15 April 2008 and it is finally here where the Examiner realized that Josse et al. (and now newly-added Thompson et al.) did not suggest making the electrodes smaller, so the *Examiner’s speculation* was created (see page 6). It should be noted that there are no references cited to support the *Examiner’s speculation* on page 6. But on page 7 the Examiner now calls the page 6 speculation “the basic facts and evidence presented by the Examiner.”

5. The Fifth Office Action was dated 28 October 2008 and expands the *Examiner’s speculation* to include a bunch of equations on pages 12 and 16 of the Office Action. It should be noted that the Office Actions are getting longer and longer, not by addition of rejections, but taking more and more verbiage (but not reference support) for the Examiner to try to justify his rejections by unsupported assertions.

Summary

The *Examiner’s speculation* is now considered a prior art reference, yet it first appeared in the file history in the Fourth Office Action dated 15 April 2008 and got expanded in the Fifth (and last) Office Action on 28 October 2008.

37C.F.R.§41.37(c)(1)(vii). Argument

A. Claims 1-5 and 8-10 and 25-28 were rejected as unpatentable under 35 U.S.C. §103 over Thompson et al. (U.S. Patent Application 2003/0076743) in view of the Examiner’s “scientific theory.”

1. **No *prima facie* case of obviousness has been established.** The “scientific theory” or “*Examiner’s speculation*” is not prior art, and cannot be used or considered as part of the rejection. Although, used to try to make up the deficiencies in Thompson et al (and Josse et al.), the endless ramblings of the Examiner and his equations are not prior art because: (a) this was not presented until the Fourth Office Action when the Examiner realized the deficiencies in Thompson et al. and Josse et al.; and (b) there is no evidence tying the *Examiner’s speculation* to a prior art reference. Therefore, the *Examiner’s speculation* is not prior art and cannot be part of a rejection. Accordingly, the rejection is over Thompson et al, that which it teaches and that which it teaches away.

In the *Examiner’s speculation*, the Examiner appears to even mischaracterize the Sauerbrey equation. Specifically, the Examiner creates a superficial misunderstanding of the Sauerbrey equation that there is a dependence between frequency shift and the area of the electrode. The Examiner fails to consider that for a smaller electrode, wherein there should be a

higher frequency shift according to the Sauerbrey equation, there is also a corresponding decrease in the amount of available binding sites, which will then cancel out the increased frequency shift. But the *Examiner's speculation* fails to consider multiple variables. The notion of the density of active sites is provided in the specification on page 9, first full paragraph and page 10, first full paragraph. It is unfortunate the Examiner never seemed to consider this before reaching a conclusion and then not considering any contradictory evidence. Therefore, the *Examiner's speculation* is overly superficial and does not take into account other factors. Thus, the *Examiner's speculation* is scientifically incorrect because the Examiner forgot to account for binding sites.

2. No *prima facie* case of obviousness can be established over Thompson et al.

because Thompson et al. does not teach or suggest element (b) of claim 1. Element (b) of claim 1 provides "a first electrode having a continuous surface area of less than 15 mm² and an electrode edge." It should be noted that none of the electrodes in Thompson et al. have a continuous surface area of less than 15 mm². Moreover, none of the electrodes in Thompson et al. have a surface area of less than 15 mm² irrespective of whether continuous or not.

However, the Examiner continues to misrepresent the teachings of Thompson et al. Specifically, the Examiner continues to allege that Thompson teaches that a person of ordinary skill in the art of Thompson et al. would be motivated to "modify[ied] the electrode geometry" (see paragraph 0031) without looking to the rest of the sentence regarding how Thompson et al. would so "modify" the electrode geometry. The relevant sentences in Thompson et al. that the Examiner takes out of context are:

Further, the invention relates to a method of enhancing acoustic wave sensor response in a TSM electrode comprising the step of modifying the electrode to include enhanced edge region. (paragraph 0029 second sentence)

* * * * *

In order to investigate and utilize these effects, we modified the electrode geometry to increase the edge length, which, in turn, raises the sensitivity of the device. (paragraph 0031 third sentence)

* * * * *

Such modifications [increasing edge length], that extend device sensitivity beyond the electrode area to the quartz region of the sensing structure also provide a better surface for the immobilization of various probes. (paragraph 0031, fifth sentence)

* * * * *

Removal of segments of the electrode will increase edge length, in turn, raising the intensity of edge fields, which will enhance the sensitivity of the device. (paragraph 0044)

Therefore, a person of ordinary skill in the art will look to the Thompson "modifications" as only increasing edge regions to increase sensitivity because increasing edge regions "extend device sensitivity beyond the electrode area to the quartz region of the sensing structure also

provide a better surface for the immobilization of various probes.”³ Accordingly, the only conclusion that can be drawn from the teachings of Thompson et al. is that it is desirable to increase sensitivity by *increasing* [not decreasing] surface area for immobilization of probes. Thompson et al. teaches that enhancing edge regions is one means for *increasing* effective electrode surface area.

The Examiner has not established a *prima facie* case of obviousness because the Examiner has grossly misrepresented the teachings of Thompson et al. and then tried to obfuscate that fact by distorting the Thompson et al. teachings and what a person of ordinary skill in the art would conclude with the “scientific theory” or *Examiner’s speculation*. Accordingly, claims 1-5 and 8-10 and 25-28 are patentable over Thompson et al. because no *prima facie* case of obviousness has ever been established by the Examiner.

3. Thompson et al. teaches away from the invention of claims 1-5 and 8-10 and 25-28. The key limitation is claim 1 limitation (b) (“a first electrode having a continuous surface area of less than 15 mm² and an electrode edge”) which is a required limitation in each of claims 1-5 and 8-10 and 25-28. The dependent claims provide for even smaller surface areas of the first electrode. As is quoted above from paragraphs 0029 and 0031, Thompson et al. teaches and suggests that that one can *increase* sensitivity by *increasing* the surface area of the electrode and that modifying electrode geometry to increase edge length is one way to effect and *increase* in electrode surface area. Therefore, Thompson et al. teaches away from the claimed invention in general and claim 1 element (b) in particular.

4. The Examiner admits that Thompson et al. teaches away from the key limitation in claim 1. In the Fifth Office Action page 11, the Examiner states: “Thompson et al. does not specifically disclose quantitative measures of the electrodes, i.e. the first crystal surface having a first electrode having a continuous surface area of less than 15mm², 10 mm², or 1-5 mm², or at least 0.05 mm² (as recited in claims 1, 2, 3, 25) or specific measures of distances between the crystal plate edge and of the electrode being 0.2 mm, 1mm or 2mm) (as recited in claims 5, 27 and 28).” Therefore, in view of the Thompson et al. disclosure in paragraphs 0029 and 0031 that indicates that the effective electrode surface is increased in enhance sensitivity by increasing electrode edge areas, the Examiner seems to be admitting that Thompson et al. not only does not disclose limitation (b) in claim 1 (and the even small surface areas of the dependent claims) but that Thompson et al. teaches away from claim 1 and its dependent claims.

Accordingly, Thompson et al teaches away from the claimed invention in general and claim 1

³ It should be noted that according to basic geometry if one decreases the surface area of a continuous electrode, such as a circular shape or a rectangular shape, the edge distance (*i.e.*, perimeter) will also decrease. Thompson et al. increased edge distance by drilling a hole to form more of a donut (*i.e.*, not continuous) shape.

element (b) in particular, and that the Examiner admits that Thompson et al teaches away from the claimed invention in general and claim 1 element (b) in particular.

5. The Aastrup Declaration provides three contemporaneous references that also teach away from the claimed invention of claim 1 and its dependent claims. Specifically, the Aastrup Declaration provides contemporaneous references (all of record herein) Lu et al. I, Lu et al. II, and Wu et al., that each suggest increasing the size of the electrode to improve sensitivity. Dr. Aastrup concludes in paragraph 7: “My conclusion from the disclosures of Lu et al. I, Lu et al. II and Wu et al. is that all three references suggest to increase the area or size of the electrodes in QCM for improving sensitivity and not make the electrodes smaller as we have done in our invention.” It does not appear that the Examiner ever considered the Aastrup Declaration, or the Examiner tried to dismiss it because it did not comport with the Examiner’s speculation. Irrespective, there are three more references that each show that that a person of ordinary skill in the art at the time of the present invention tried to increase sensitivity by increasing electrode surface area. Therefore, each of Lu et al. I, Lu et al. II and Wu et al. teach away from the claimed invention. Accordingly, in the unlikely event that a *prima facie* case of obviousness is found, applicants have satisfied their burden of proof by showing that Thompson et al. Lu et al. I, Lu et al. II and Wu et al. (four references) each teach away from the claimed invention of claim 1.

6. Applicants have satisfied their burden of providing surprising results to support the patentability of claims 1-5 and 8-10 and 25-28 over Thompson et al. Applicants have consistently pointed to the surprising results achieved in the specification. Specifically, the example on pages 17-19 along with the data shown in Figures 8 and 9 provided “a sensitivity increase exceeding a factor of ten.” (page 18 lines 8-9). Applicants further point to these surprising results throughout the specification as the basis for the claimed invention of claim 1 and those claims that depend from claim 1. For example, the object of the invention is improved sensitivity (page 2 lines 22-23) and page 3 lines 4-5. Moreover, the first sentence in the “Description of the embodiments” section states: “The present invention is based on the surprising finding that a smaller sensing electrode area leads to a largely increased sensitivity of a piezoelectric resonator.” The data are summarized on page 10 lines 15-18 (“It has been found that the sensing electrode should have a surface area of between 0,05 [0.05 in a U.S. style] and 15 mm², preferably 1-5 mm² in order to obtain a satisfying sensitivity in sensing applications for detection or measuring of analytes in liquid or gaseous media.”) and on page 10 lines 7-9 (“It has now been found that a smaller electrode area result in a higher sensitivity, since the alteration in resonance frequency is dependent on the alteration in the mass of the electrode, which is caused by the interaction between the electrode and the substances to be detected/measured.”). Therefore, there are

surprising results provided in the specification that should have been considered before a conclusion of obviousness was reached by the Examiner.⁴

7. **Summary.** The Examiner has not provided a *prima facie* showing of obviousness because the Examiner relies on a “scientific theory” or “*Examiner’s speculation*” to support the admitted deficiencies in Thompson et al. The *Examiner’s speculation* is not prior art and is not even scientifically correct. Moreover, even if a *prima facie* showing of obviousness was established, the burden of proof shifts and applicants have established, through evidence of record, that Thompson et al. teaches away from the claimed invention, the Aastrup Declaration provides three more references that each teach away from the claimed invention, and there is a showing of surprising results in the specification.

B. Claims 1-5 and 8-10 and 25-28 were rejected as unpatentable under 35 U.S.C. §103 over Josse et al. (U.S. Patent 5,852,229) in view of the Examiner’s “scientific theory.”

1. **No *prima facie* case of obviousness has been established.** The “scientific theory” or “*Examiner’s speculation*” is not prior art, and cannot be used or considered as part of the rejection. Although, used to try to make up the deficiencies in Josse et al., the endless ramblings of the Examiner and his equations are not prior art because: (a) this was not presented until the Fourth Office Action when the Examiner realized the deficiencies in Josse et al.; and (b) there is no evidence tying the *Examiner’s speculation* to a prior art reference. Therefore, the *Examiner’s speculation* is not prior art and cannot be part of a rejection. Accordingly, the rejection is over Josse et al. alone, that which it teaches and that which it teaches away.

In the *Examiner’s speculation*, the Examiner appears to even mischaracterize the Sauerbrey equation. Specifically, the Examiner creates a superficial misunderstanding of the Sauerbrey equation that there is a dependence between frequency shift and the area of the electrode. The Examiner fails to consider that for a smaller electrode, that should provide a higher frequency shift according to the Sauerbrey equation, there is also a corresponding decrease in the amount of available binding sites, which will then cancel out the increased frequency shift. The notion of the density of active sites is provided in the specification on page 9 first full paragraph and page 10, first full paragraph. It is unfortunate the Examiner never seemed to consider this before reaching a conclusion, and then not considering any contradictory evidence. Therefore, the *Examiner’s speculation* is overly superficial and does not take into account other factors, rendering the

⁴ MPEP§2142 provides: “When an applicant submits evidence, whether in the specification as originally filed or in reply to a rejection, the examiner must reconsider the patentability of the claimed invention. The decision on patentability must be made based upon consideration of all the evidence, including the evidence submitted by the examiner and the evidence submitted by the applicant.”

Examiner's speculation to be scientifically incorrect because the Examiner forgot to account for binding sites.

2. **No *prima facie* case of obviousness can be established over Josse et al.** because Josse et al. does not teach or suggest element (b) of claim 1. Element (b) of claim 1 provides "a first electrode having a continuous surface area of less than 15 mm² and an electrode edge." It should be noted that none of the electrodes in Josse et al. have a continuous surface area of less than 15 mm². Moreover, none of the electrodes in Josse et al. have a surface area of less than 15 mm² irrespective of whether continuous or not.

The Examiner again admits that Josse et al. does not disclose or suggest the limitation of claim 1 ("a continuous surface area of less than 15 mm²"), but instead somehow dances around this issue by stating: "Although Josse et al. does not disclose specific quantitative surface areas of the electrode(s), that is, specific dimensional/geometric aspects of the electrodes(s) (i.e. surface area <15 mm² or 10 mm² or is 1-5 mm² or the distances between the crystal edge and the electrode edge being at least 0.2 mm or 1 mm or 2 mm) (as recited in claims 1-3, 5 and 25-28), Josse et al. does carefully teach and explain that 'conductivity of the loading medium results in the expansion of the effective electrode surface area, and that the electrode regions and their electrostatic capacitance is a result of the electrode size, shape and configuration, in other words, the electrode surface area.'"

The only citation the Examiner has made to Josse et al. is col. 2 lines 14-25. This makes no sense because lines 14-25 start and end mid-sentence, yet this is the Examiner's only reference to Josse et al. In the interest of completeness, the two paragraphs that comprise col. 2 lines 1-31 are reproduced below:

Acoustic wave chemical sensors and biosensors thus consist of a piezoelectric crystal device and a chemical system attached to the crystal surface. The chemical system consists of the polymeric coating and/or chemoreceptors attached to the coating. The chemical system is used as a molecular recognition element and has the ability to selectively bind molecules and gas particles. While the physics of the detection process is very complex, the principle of operation of acoustic wave device sensor is quite simple and the results are reliable. An acoustic wave confined to the surface (SAW) or bulk (BAW) of a piezoelectric substrate material is generated and allowed to propagate. Any matter that happens to be present on the crystal surface will perturb that surface in such a way as to alter the properties of the wave (i.e. velocity or frequency, amplitude or attenuation). The measurement of changes in the wave characteristics is a sensitive indicator of the properties of the material present on the surface of the device. In general, it is well known that both mechanical and electrical perturbations of the surface affect the propagating acoustic waves and result in sensing. Such perturbations result from the absorption or diffusion of gas into the film; molecule selectivity, migration or binding; and formation of complexes within the film.

Prior art devices have focused on the mass loading effect in the implementation of those devices. In those devices, the gas is absorbed by the film thereby increasing the mass of the film and change the wave frequency and/or attenuation. The change in frequency has been shown to be a direct function of the amount of gas absorbed. Because the added mass is very small, the acoustic wave perturbation may be small.

Focusing on the key limitation (b) of claim 1, applicants have never been able to decipher where in Josse et al. the Examiner has obtained his teachings. In fact, it looks like the Examiner has only turned to Josse et al. Figures 1a and 1b that show ring or donut hole structures and not continuous electrodes having “a continuous surface area of less than 15 mm².”

As best applicants can determine, Josse et al. seems to focus on the electrode size differences between a first and a second electrode, but not on making the first electrode smaller. The Examiner noted this in the First Office Action by stating: “Josse et al. further teach that the geometries and/or surface areas of the first and second electrodes must differ and that the variations affect the critical frequencies in a predictable way.” Therefore, what Josse et al. does teach is the relationship in size between the first and second electrodes, but not the key limitation (claim 1 element (b)) that provides “a first electrode having a continuous surface area of less than 15 mm² and an electrode edge.” Therefore, Josse et al. teach away from claim 1 element (b) by suggesting the relationship in size between the first and second electrodes and not by making the

first electrode smaller to the point of having the surface area of the first electrode less than 15 mm². Therefore, the Examiner’s conclusions are not supported in any teaching or suggestion in Josse et al. Nor has the Examiner pointed to any supporting disclosure in Josse et al.

Therefore, the Examiner has not established a *prima facie* case of obviousness because the Examiner has drawn conclusions not supported by any of the teachings of Josse et al. or any other evidence. Moreover, the Examiner then tried to obfuscate the lack of support in Josse et al. by distorting the Josse et al. teachings and what a person of ordinary skill in the art would conclude with the “scientific theory” or *Examiner’s speculation*. Accordingly, claims 1-5 and 8-10 and 25-28 are patentable over Josse et al. because no *prima facie* case of obviousness has ever been established by the Examiner.

3. The Aastrup Declaration provides three contemporaneous references that also teach away from the claimed invention of claim 1 and its dependent claims. Specifically, the Aastrup Declaration provides contemporaneous references (all of record herein) Lu et al. I, Lu et al. II, and Wu et al., that each suggest increasing the size of the electrode to improve sensitivity. Dr. Aastrup concludes in paragraph 7: “My conclusion from the disclosures of Lu et al. I, Lu et al. II and Wu et al. is that all three references suggest to increase the area or size of the electrodes in QCM for improving sensitivity and not make the electrodes smaller as we have done in our invention.” It does not appear that the Examiner ever considered the Aastrup Declaration, or tried to dismiss it because it did not comport with the Examiner’s speculation. Irrespective, there are three more references that each show that that a person of ordinary skill in the art at the time of the present invention tried to increase sensitivity by increasing electrode surface area. Therefore, each of Lu et al. I, Lu et al. II and Wu et al. teach away from the claimed invention. Accordingly, in the unlikely event that a *prima facie* case of obviousness is found, applicants have satisfied their burden of proof by showing that Thompson et al. Lu et al. I, Lu et al. II and Wu et al. (four references) each teach away from the claimed invention of claim 1.

4. The Examiner admits that Josse et al. teaches away from the key limitation in claim 1. In the First Office Action the Examiner admits that “Although Josse et al. does not disclose specific quantitative surface area, that is, specific dimensional/geometrical aspects of the electrodes . . . **Josse et al. does carefully teach and explain that ‘conductivity of the loading medium results in the expansion of the effective electrode surface area**, and that the electrode regions and their electrostatic capacitance is a result of the electrode size, shape and configuration, in other words, the electrode surface area.” (emphasis added). Therefore, the Examiner has now admitted that Josse et al. teaches away from the claimed invention by suggesting an “expansion” of the surface area, not a smaller surface area. Accordingly, Josse et al teaches away from the claimed invention in general and claim 1 element (b) in particular, and that the Examiner admits

that Josse et al teaches away from the claimed invention in general and claim 1 element (b) in particular.

5. **Applicants have satisfied their burden of providing surprising results to support the patentability of claims 1-5 and 8-10 and 25-28 over Josse et al.** Applicants have consistently pointed to the surprising results achieved in the specification. Specifically, the example on pages 17-19 along with the data shown in Figures 8 and 9 provided “a sensitivity increase exceeding a factor of ten.” (page 18 lines 8-9). Applicants further point to these surprising results throughout the specification as the basis for the claimed invention of claim 1 and those claims that depend from claim 1. For example, the object of the invention is improved sensitivity (page 2 lines 22-23) and page 3 lines 4-5. Moreover, the first sentence in the “Description of the embodiments” section states: “The present invention is based on the surprising finding that a smaller sensing electrode area leads to a largely increased sensitivity of a piezoelectric resonator.” The data are summarized on page 10 lines 15-18 (“It has been found that the sensing electrode should have a surface area of between 0,05 [0.05 in a U.S. style] and 15 mm², preferably 1-5 mm² in order to obtain a satisfying sensitivity in sensing applications for detection or measuring of analytes in liquid or gaseous media.”) and on page 10 lines 7-9 (“It has now been found that a smaller electrode area result in a higher sensitivity, since the alteration in resonance frequency is dependent on the alteration in the mass of the electrode, which is caused by the interaction between the electrode and the substances to be detected/measured.”). Therefore, there are surprising results provided in the specification that should have been considered before a conclusion of obviousness was reached by the Examiner.⁵

6. **Summary.** The Examiner has not provided a *prima facie* showing of obviousness because the Examiner relies on a “scientific theory” or “Examiner’s speculation to support the admitted deficiencies in Josse et al. The Examiner’s speculation is not prior art and is not even scientifically correct. Moreover, even if a *prima facie* showing of obviousness was established, the burden of proof shifts and applicants have established through evidence of record that Thompson et al., Lu et al. I, Lu et al. II and Wu et al. each teaches away from the claimed invention. Further, there is a showing of surprising results in the specification.

⁵ MPEP§2142 provides: “When an applicant submits evidence, whether in the specification as originally filed or in reply to a rejection, the examiner must reconsider the patentability of the claimed invention. The decision on patentability must be made based upon consideration of all the evidence, including the evidence submitted by the examiner and the evidence submitted by the applicant.”

In view of the foregoing arguments, Aastrup Declaration, and the entire file history, applicants respectfully request withdrawal of the rejections to claims 1-5, 8-10 and 23-28, and allowance of pending claims 1-13 and 23-28.

Respectfully submitted,
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Appendix A

Pending Claims

1. (previously presented) A thickness shear mode piezoelectric resonator for use in a sensor arrangement for detecting or measuring an analyte in a medium by mass changes, comprising: a quartz crystal plate having a first crystal surface having an edge and a second crystal surface, said first crystal surface comprises a first electrode having a continuous surface area of less than 15 mm² and an electrode edge, said second crystal surface comprises a second electrode.

2. (previously presented) The resonator of claim 1, wherein the continuous surface area of the first electrode is less than 10mm².

3. (previously presented) The resonator according to claim 1, wherein the continuous surface area of the first electrode is at least 0.05mm².

4. (previously presented) The resonator according to claim 1, wherein the continuous surface area of the first electrode is smaller than the first crystal surface.

5. (previously presented) The resonator according to claim 1, wherein the distance from the first electrode edge to the crystal edge is at least 0.2mm².

6. (previously presented) The resonator according to claim 1, wherein the distance from the sensing electrode edge to the crystal edge is at least 0.2mm².

7. (previously presented) The resonator according to claim 1, wherein the first electrode has a rectangular-shaped surface, having a first side and a second side.

8. (previously presented) The resonator according to claim 1, wherein the first crystal surface is provided with a first contacting area connected to the first electrode; and the second crystal surface is provided with a second area connected to the second electrode.

9. (previously presented) The resonator according to claim 1, wherein the first electrode has a first side and a second side; and the first contacting area is connected to the second side of the first electrode.

10. (previously presented) The resonator according to claim 1, wherein the first crystal surface and the second crystal surface are flat.

11. (previously presented) The resonator according to claim 1, wherein the quartz crystal is an inverted mesa.

12. (previously presented) The resonator of claim 11, wherein the quartz crystal plate comprises a first recess having a wall and a bottom surface and a first electrode in the first recess; the area of the bottom surface is larger than the first electrode; and the first electrode is arranged in the recess such that there is a distance between the electrode and the recess wall.

13. (previously presented) The resonator of claim 11, wherein the shortest distance from the electrode to the recess wall is at least 0.01 mm.

Claims 14-22 have been cancelled.

23. (previously presented) A method of sensing or measuring, comprising using a thickness shear mode resonator according to claim 1 to sense or measure.

24. (previously presented) The method according to claim 23, wherein the resonator is used to sense or measure of liquid samples.

25. (previously presented) The resonator according to claim 1, wherein the continuous surface area of the first electrode is 1-5 mm².

26. (currently amended) The resonator according to claim 4, wherein the first electrode has a continuous surface area that is 0.1-90% of the crystal area.

27. (previously presented) The resonator according to claim 5, wherein the distance from the sensing electrode edge to the crystal edge is at least 1 mm.

28. (previously presented) The resonator according to claim 27, wherein the distance from the sensing electrode edge to the crystal edge is at least 2 mm.

Claims 29-37 have been cancelled.

Appendix B Aastrup Declaration

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	10/642,616	Configuration No.:	7334
Applicants:	Teodor Aastrup et al.		
Filing Date:	18 July 2005		
Art Unit:	2856		
Examiner:	John Fitzgerald		
Attorney Docket No.:	ATTANA-2		
Customer No.:	29039		
Title:	Piezoelectric Resonator		
Date:	21 January 2008		

Declaration of Teodor Aastrup, Ph.D. Under 37 C.F.R. § 1.132

I, Teodor Aastrup, hereby declare as follows:

1. I am a co-inventor of the above identified patent application entitled "Piezoelectric Resonator." I obtained my MSc degree in materials physics at Uppsala University in Sweden in 1994 and my Ph.D. at the Royal Institute of Technology, Sweden, in 1999. As part of my graduate studies I built my first Quartz Crystal Microbalance (QCM) setup in 1995. I have published 17 peer-reviewed publications related to QCM technology. I am able to communicate in the English language.
2. Three publications discussing Quartz Crystal Microbalance (QCM) sensors published shortly after the priority date of the above identified patent application have studied the impact of QCM electrode size to the sensitivity of the device:
 3. Lu et al. states that "the sensitivity of QCM also decreases as the electrode size decreases." (Page 206, column 2, line 15) (emphasis added). Lu et al. goes on to state that "Since the QCM is mostly used to detect the thickness of absorbtions, larger electrode size provide higher sensitivity to thickness of absorbtion." (Page 207, column 1, line 6) (emphasis added). Figure 3 presented in Lu et al. 1 (reproduced below) shows that the mass sensitivity of the QCM

F. Lu, H.P. Lee, S.P. Lim, Quartz crystal microbalance with integrated microelectromechanical system, *Journal of Microelectromechanical Systems* 14(2) 201-209 (2005) (hereinafter "Lu et al. 1").
F. Lu, S.P. Lim, H.P. Lee, A novel analytical method for the frequency-based quantification of the mass balance, *Sensors and Actuators A* 138 (2008) 89-92 (hereinafter "Lu et al. 2").
D.H. Wu, L.T. Yang, F.Y. Yu, Real-time capacitance-based microbalance with time derivative approach, *Sensors and Actuators A* 142 (2008) 237-244.



will be impaired if the electrode diameter is decreased. D is the electrode diameter and τ is the thickness of the crystal, here 0.2mm.

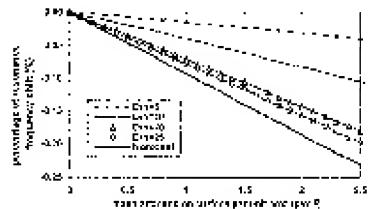


Fig. 3. Dependence of QCM is a function of mass sensitivity on electrode width in micrometers.

4. Lu et al. II elaborate further on the relationship between sensor electrode dimensions and sensitivity. Specifically, Lu et al. II states: "The mass sensitivity of the single QCM as a function of the electrode width is shown in Fig. 4. It is seen that the mass sensitivity is related to the electrode size. With increasing electrode width, the mass-frequency sensitivity approaches towards the results evaluated from Sauerbrey equation. When the electrode size is smaller, the difference between Sauerbrey equation and FEM result is quite larger. This can be explained that when the electrode width is smaller, a larger amount of vibration energy is dispersed into the surrounding quartz plate outer of the electrode region" (Page 93, column 1, line 13). Figure 4 from Lu et al. II is presented below.

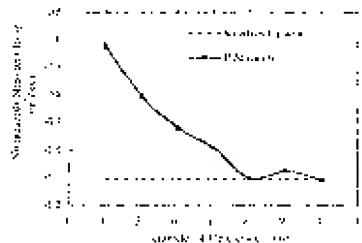
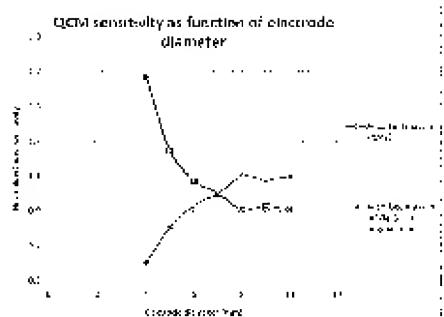


Fig. 4. Normalized mass sensitivity of single QCM as a function of the electrode diameter.

5. I have re-drawn Figure 4 from Lu et al. II to show the comparative data from Lu et al. II in a less confusing manner below:

OK

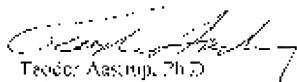


6. Wu et al. in 2003 discloses design parameters for QCMs by means of finite element analysis. Wu et al. report in Figure 10 of the paper (parameter B as described in Table 6), that increasing the radius of a QCM from 2.5nm to 5nm significantly improves the signal to noise ratio, i.e., the sensitivity of the device.

7. My conclusion from the disclosures of Lu et al. 1, Lu et al. 2 and Wu et al. is that all three references suggest to increase the area or size of the electrodes in QCM for improving sensitivity and not make the electrodes smaller as we have done in our invention.

8. All statements that I make herein, of my own knowledge are true and all statements made on information and belief, are believed to be true. I acknowledge that willfully making false statements and the like are punishable by fine, imprisonment, or both, under 35 U.S.C. § 1001, and that such willful, false statement may jeopardize the validity of any patent issuing from this patent application.

Signed the 21st day of January 2008 in Stockholm, Sweden


Teodor Aasump, Ph.D.

Text of Aastrup Declaration:

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: 10/542,616 Confirmation No.: 7334

Applicants: Teodor Aastrup et al.

Filing Date: 18 July 2005

Art Unit: 2856

Examiner: John Fitzgerald

Attorney Docket No.: ATTANA-2

Customer No.: 29039

Title: Piezoelectric Resonator

Date: 21 January 2008

Declaration of Teodor Aastrup, Ph.D. Under 37 C.F.R. §1.132

I, Theodor Aastrup, hereby declare as follows:P

1. I am a co-inventor of the above-identified patent application entitled “Piezoelectric Resonator.” I obtained his MSc degree in materials physics at Uppsala University in Sweden in 1994 and my Ph.D. at the Royal Institute of Technology, Sweden, in 1999. A part of my graduate studies I built my first Quartz Crystal Microbalance (QCM) setup in 1994. I have published 17 peer reviewed publications related to QCM technology. I am able to communicate in the English language.

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3. Lu et al I states that “the **sensitivity** of QCM also **decreases** as the electrode size **decreases.**” (Page 206, column 2, line 15) (emphasis added). Lu et al. I goes on to state that “Since the QCM is mostly used to detect the thickness of absorbtion, **larger electrode size provide higher sensitivity to thickness of absorbtion.**” (Page 207, column 1, line 6) (emphasis added).

⁶ F. Lu, H.P. Lee, S.P. Lim, Quartz crystal microbalance with rigid mass partially attached on electrode surfaces, *Sens. Actuators A* 112 (3–4) (2004) 203–210. [Lu et al. I]

F. Lu, H.P. Lee, P. Lu, S.P. Lim, Finite element analysis of interference for the laterally coupled quartz crystal microbalances, *Sensors and Actuators A* 119 (2005) 90–99 [Lu et al. II]

D.H. Wu, J.T. Yng, T.Y. Yu, Robust design of quartz crystal microbalance using finite element and Taguchi method, *Sens. Actuators B* 92 (2003) 337–344.

Figure 3 presented in Lu et al. I (reproduced below) shows that the mass sensitivity of the QCM will be impaired if the electrode diameter is decreased. D is the electrode diameter and h is the thickness of the crystal, here 0.2mm.

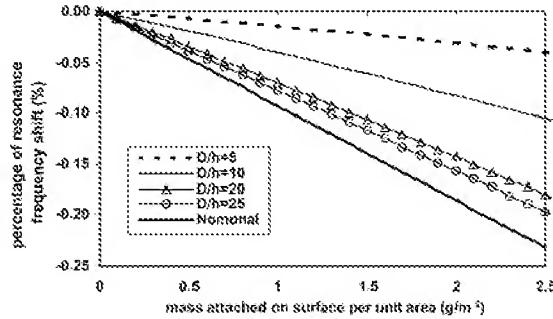


Fig. 3. Frequency sensitivity of QCM as a function of mass absorption unit area with different size of electrode size.

4. Lu et al. II elaborate further on the relationship between sensor electrode dimensions and sensitivity. Specifically, Lu et al. II states: “The mass sensitivity of the single QCM as a function of the electrode width is shown in Fig. 4. It is seen that the mass sensitivity is related to the electrode size. With increasing electrode width, the mass–frequency sensitivity approaches towards the results evaluated from Sauerbrey equation. When the electrode size is smaller, the difference between Sauerbrey equation and FEM result is quite larger. This can be explained that when the electrode width is smaller, a larger amount of vibration energy is dispersed into the surrounding quartz plate outer of the electrode region.” (Page 93, column 1, line 13). Figure 4 from Lu et al. II is presented below.

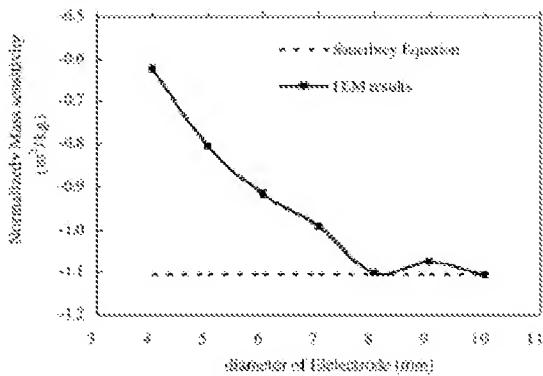
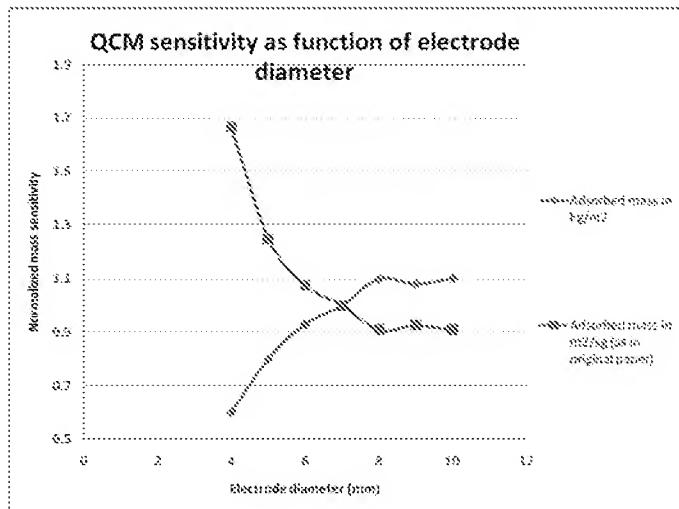


Fig. 4. Normalized mass sensitivity of single QCM ψ_f as a function of the electrode diameter.

5. I have re-drawn Figure 4 from Lu et al. II to show the comparative data from Lu et al. II in a less confusing manner below:



6. Wu et al. in 2003 discloses design parameters for QCMs by means of finite element analysis. Wu et al. report in Figure 10 of the paper (parameter B as described in Table 6), that increasing the radius of a QCM from 2mm to 3mm significantly improves the signal to noise ratio, *i.e.*, the sensitivity of the device.

7. My conclusion from the disclosures of Lu et al. I, Lu et al. II and Wu et al. is that all three references suggest to increase the area or size of the electrodes in QCM for improving sensitivity and not make the electrodes smaller as we have done in our invention.

8. All statements that I make herein of my own knowledge are true and all statements made on information and belief, are believed to be true. I acknowledge that willfully making false statements and the like are punishable by fine, imprisonment, or both, under 35 U.S.C. §1001, and that such willful, false statement may jeopardize the validity of any patent issuing from this patent application.

Signed the 21st day of January 2008 in Stockholm, Sweden

Teodor Aastrup, Ph.D.